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LISTS OF SPECIES

Ichthyofauna of the Aiuruoca River basin, Minas Gerais, Brazil

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ABSTRACT: Although the Aiuruoca River is recognized as a very important area for fish fauna, the species composition of this river remains unknown or restricted to technical reports of licensing projects. The aim of this study was to describe the composition and distribution of the ichthyofauna in the Aiuruoca River basin. Fifty-eight collection points were sampled along the Aiuruoca River basin during 2010 and 2011, including 38 streams, 11 lagoons and 9 points along the Aiuruoca River main channel. A total of 8562 specimens were collected belonging to 6 orders, 15 families, 33 genera and 47 species. The pirapetinga fish (*Brycon nattereri*) is listed on Brazil's endangered species, and the rainbow trout (*Oncorhynchus mykiss*) was the only exotic species captured. Altitude is one of the main factors that influence fish community structure in the Aiuruoca River basin, confirming its importance for fish conservation.

INTRODUCTION

There is a scientific consensus that the long-term maintenance of biodiversity would benefit greatly from conservation plans that act on a regional scale or include large tracts of land (Center for Applied Biodiversity Science 2000). The identification of areas with high species diversity is an essential component for protecting biodiversity (Allan and Flecker 1993).

The Aiuruoca River basin is considered as one of very high biological importance for conservation of the ichthyofauna in Minas Gerais State, Brazil (Biodiversitas 2005) because it is an important lotic remnant of the Upper Grande River basin and has high water quality. River damming is one of the major threats to the fish found in Grande River basin.

Although the Aiuruoca River is recognized as a very important area for fish fauna, practically all of the basic requirements for adequate conservation strategies are lacking, especially because the species composition remains unknown or restricted to technical reports of licensing projects. Therefore, the aim of this study was to describe the composition and distribution of the ichthyofauna in the Aiuruoca River basin.

MATERIAL AND METHODS

Study Area

The study basin is located in the Upper Grande River region in southern Minas Gerais. The Aiuruoca River has a drainage area of 2,094 km^2 and is located upstream of the Camargos Reservoir (Figure 1), and it drains areas designated as buffer zones for the Conservation Unit APA Mantiqueira (Environmental Protection Area of the Mantiqueira mountain) . (Lino and Albuquerque 2007). The streams and rivers in this region have cold, clean and well-oxygenated water, which are characteristics unique to headwaters (Uieda and Castro 1999).

Fish sampling

Fifty-eight sampling stations were evaluated along the Aiuruoca River basin during 2010 and 2011 (Table 1). The water bodies sampled included 38 streams, 11 lagoons and 9 points along the Aiuruoca River channel that were specifically selected to maximize the diversity of the sampled environments and to represent the complete composition of the basin's ichthyofauna .

A 150-meter long section of each stream was sampled once during the dry season. Each section was subdivided into 10 cross-sections, and each cross-section covered 1/10 of the total length. Fish collections were performed downstream to upstream with sieves made from mosquito netting (80 cm in diameter, 1 mm mesh size). Two sieves were used for each stream, and collection time was standardized, in 12 minutes per each stream cross-section max.

Lagoons were also sampled once immediately after the Aiuruoca River flooding season between December 2010 and February 2011. Fish collection was performed using two sieves made from mosquito netting (1 mm mesh size) and trawling nets (50 mm mesh size).

Stations along the Aiuruoca River were sampled during the rainy season (November 2010) and the dry season (May 2011). At each point in the river, a combination of gillnets (2.4 cm to 14 cm mesh size) was set in the afternoon and retrieved the next morning. Sieves and trawling nets were also used at these points whenever possible.

Sampling stations were defined based on a 1:250.000 cartographic map IBGE, and comprised all possible streams considering the possibility of access. The average altitude for each of the 58 points was measured using a GPS unit (Garmin Etrex Venture).

A species accumulation curve was created for all of the points sampled in the Aiuruoca River basin, where at least one fish species was recorded, based on 500

randomizations, and the total richness was compared via the Jackknife1 and Chao1 estimators, using the EstimateS 8.0 software (Colwell 2006).

Samples of the collected specimens were subsequently deposited in the Federal University of Lavras (UFLA) Fish Collection (Table 2). Fish were collected under the IBAMA license # 10 327.

Results and Discussion

A total of 8562 specimens were collected belonging to 6 orders, 15 families, 33 genera and 47 species (Table 2). One of them, the Pirapetinga (*Brycon nattereri*) is listed on Brazil's endangered species official list as vulnerable (Machado *et al.* 2005). The distribution area for this species confirms its preference for small, protected rivers and headwaters (Pompeu *et al.* 2009). Additionally, the rainbow trout (*Oncorhynchus mykiss*) was the only exotic species captured. It was introduced by the hatchery industry in the cold-water regions of the Mantiqueira mountains. Due to its unique biological traits, such as being omnivorous and hiding its offspring from predators, this species is considered a pest that causes adverse ecological effects in the various countries and regions where it has been introduced (Magalhães *et al.* 2002).The majority of the biodiversity occurred in the Characiformes (53%) and Siluriformes (36%) orders, which also had the largest number of individuals collected (78% of the total catch). This pattern has been identified repeatedly throughout similar research in South America (Lowe-McConnell 1987). However, although Siluriformes from the Loricariidae and Trichomycteridae families were the most common fish in the streams, the most common species found in the river were from the Characidae family. The Characidae ichthyofauna consists of fish with very diverse feeding habits (i.e., herbivores, omnivores and carnivores) that exploit a wide range of habitats (Kavalco and Pazza 2007). Conversely, Siluriformes were preferential to rapids typical of headwater streams, which are characterized by high water velocity, low temperature and rocky bottoms (Casatti and Castro 2006).

Although 52 sampling stations had been sampled, the collector's curve was not totally stabilized (Figure 2). The estimated richness by Jackknife1 and Chao1 estimators indicated that the number of registered species represented 84% and 98% of the richness in the region, respectively. The areas where the majority of the species were recorded were lagoons, followed by streams and the Aiuruoca River. Thirty-four species had previously been identified in the Rio Grande (Cemig 2007), 41 species in the Capivari River (Pompeu *et al.* 2009) and 25 species in the Itutinga reservoir (Alves *et al.* 1998). With the addition of 16 species in this study, 88 species have been identified in the Rio Grande basin in Minas Gerais. Among the additional species, 11 were collected from streams and the other 5 species were collected from lagoons and the river channel, indicating that much of the unknown fauna in this basin is likely concentrated in small water bodies.

We also observed that only small species of the Loricariidae family, *Pareiorhina carrancas* and *Pareiorhaphis* sp. n., were recorded at altitudes above

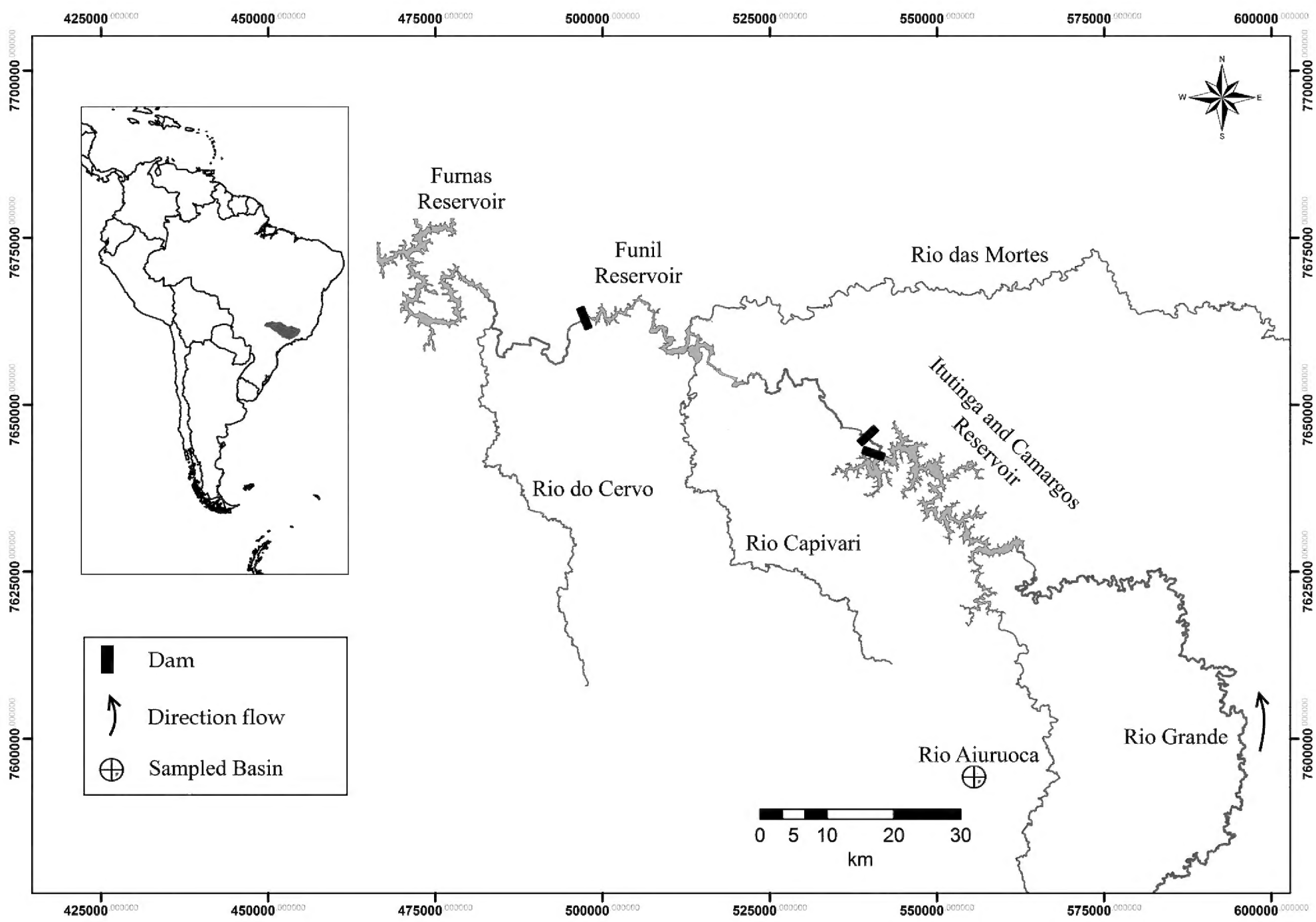

Figure 1. Map indicating the studied basin, Aiuruoca River, located in the Upper Rio Grande Region, upstream of the Camargos Reservoir in southern state Minas Gerais, Brazil.

Table 1. Geographic information of sampling stations in Aiuruoca River basin (* water bodies without denomination in the IBGE cartographic map).

	SAMPLING STATION	CITY	ALTITUDE (M)	GEOGRAPHIC COORDINATES
1	Córrego Afluente Tamanduá	Aiuruoca	1155	44°33'29" W / 22°05'07" S
2	Córrego Cangalhas	Aiuruoca	1115	44°36'59" W / 22°05'26" S
3	Córrego *	São Vicente de Minas	921	44°24'10" W / 21°36'06" S
4	Córrego Comunidade Prateado	Itamonte	1126	44°39'11" W / 22°11'26" S
5	Corrego Cachoeira da Fragária	Itamonte	1570	44°42'07" W / 22°16'48" S
6	Córrego Campina	Alagoa	1118	44°37'28" W / 22°08'21" S
7	Córrego Campo Redondo	Itamonte	1534	44°41'42" W / 22°16'00" S
8	Córrego da Cidreira	Aiuruoca	1120	44°38'01" W / 22°11'40" S
9	Córrego da Divisa	Alagoa	1097	44°35'45" W / 22°03'48" S
10	Córrego da Mata no Quilombo	Itamonte	1386	44°42'45" W / 22°13'06" S
11	Córrego da Olaria	Alagoa	1115	44°37'11" W / 22°08'14" S
12	Córrego das Abelhas	Itamonte	1426	44°42'34" W / 22°13'08" S
13	Córrego das Cobras	Alagoa	1112	44°38'04" W / 22°09'43" S
14	Córrego do Corguinho	Aiuruoca	1122	44°37'07" W / 22°10'24" S
15	Córrego do Josuel	Itamonte	1471	44°41'56" W / 22°19'02" S
16	Córrego do Mato Grosso	Itamonte	1630	44°42'12" W / 22°19'47" S
17	Córrego do Meio	Itamonte	1367	44°42'40" W / 22°14'35" S
18	Córrego do Ouro	Itamonte	1680	44°41'03" W / 22°19'21" S
19	Córrego do Quilombo	Itamonte	1275	44°41'50" W / 22°11'34" S
20	Córrego Dois Irmãos	Itamonte	1270	44°40'06" W / 22°14'43" S
21	Córrego Fundo	Alagoa	1088	44°35'50" W / 22°02'49" S
22	Córrego *	Itamonte	1357	44°42'04" W / 22°18'01" S
23	Córrego Ingrid	Itamonte	1332	44°41'29" W / 22°14'31" S
24	Córrego João Vieira	Itamonte	1373	44°41'47" W / 22°17'41" S
25	Córrego Martins	Itamonte	1229	44°40'46" W / 22°11'40" S
26	Córrego Mato Grosso	Itamonte	1190	44°38'48" W / 22°12'49" S
27	Córrego Quilombo	Itamonte	1296	44°41'44" W / 22°12'15" S
28	Córrego Vargem Grande	Itamonte	1902	44°44'08" W / 22°20'12" S
29	Córrego dos Quatro	Aiuruoca	1098	44°34'23" W / 22°05'30" S
30	Córrego *	Itamonte	1283	44°40'08" W / 22°14'41" S
31	Córrego Olaria	Aiuruoca	973	44°36'29" W / 21°59'39" S
32	Córrego Ouro 2	Aiuruoca	1680	44°41'03" W / 22°19'21" S
33	Córrego Ribeirão da Aberta	Itamonte	1403	44°43'37" W / 22°14'34" S
34	CórregoRibeirão do Condado	Aiuruoca	1132	44°37'02" W / 22°11'22" S
35	Córrego Ribeirão do Papagaio	Aiuruoca	1026	44°36'45" W / 22°00'41" S
36	Córrego Ribeirão Vermelho	Itamonte	1136	44°40'29" W / 22°11'05" S
37	CórregoTamanduá	Aiuruoca	1176	44°33'09" W / 22°05'14" S
38	CórregoTrabanda	Aiuruoca	1099	44°35'34" W / 22°05'39" S
39	Rio Aiuruoca	Aiuruoca	1372	44°41'47" W / 22°17'42" S
40	Rio Aiuruoca	Itamonte	1414	44°42'07" W / 22°18'30" S
41	Rio Aiuruoca	Aiuruoca	1052	44°36'29" W / 22°01'58" S
42	Rio Aiuruoca	São Vicente de Minas	923	44°24'26" W / 21°42'30" S
43	Rio Aiuruoca	São Vicente de Minas	920	44°24'16" W / 21°36'03" S
44	Rio Aiuruoca	São Vicente de Minas	926	44°24'15" W / 21°36'03" S
45	Rio Aiuruoca	Aiuruoca	977	44°36'20" W / 21°59'54" S
46	Rio Aiuruoca	Aiuruoca	980	44°36'21" W / 21°59'45" S
47	Rio Aiuruoca	Aiuruoca	974	44°36'26" W / 21°59'36" S
48	Rio Aiuruoca	Aiuruoca	1083	44°35'25" W / 22°05'29" S
49	Lagoa *	São Vicente de Minas	921	44°24'10" W / 21°36'06" S
50	Lagoa *	Aiuruoca	980	44°34'28" W / 21°55'29" S
51	Lagoa Bela Vista	São Vicente de Minas	931	44°23'11" W / 21°38'33" S
52	Lagoa Furado	São Vicente de Minas	918	44°23'16" W / 21°38'38" S
53	Lagoa Pequena	São Vicente de Minas	919	44°23'26" W / 21°38'58" S
54	Lagoa do Brejo	São Vicente de Minas	934	44°24'24" W / 21°42'14" S
55	Lagoa Serena	São Vicente de Minas	936	44°22'13" W / 21°39'44" S
56	Lagoa do Trem	São Vicente de Minas	926	44°23'57" W / 21°42'36" S
57	Lagoa Draga	Aiuruoca	933	44°24'27" W / 21°42'29" S
58	Lagoa do Trem 2	São Vicente de Minas	929	44°23'57" W / 21°42'32" S

1600 m (Figure 3). A total of 9 species were found above an altitude of 1050 m, while 25 where restrict to areas under 1000 m of altitude. Although the studies available considering the upper Rio Grande fish fauna do not cover the same altitudinal range, degree of conservation, altitude and width have been considered important parameters to explained fish species richness (Pompeu *et al.*, 2009). In the same study, *P. carrancas* and *Pareiorhaphis* sp. n. were among those with higher distribution considering the altitudinal gradient.

Relief is also probably one important factor that influences fish community structure in the Aiuruoca River basin. Its importance can be observed in the altitudinal distribution of species, which revealed the role of a large waterfall, located in the Aiuruoca River channel at an altitude of 1040 meters, as a barrier to species dispersal. A larger diversity of fish in the lower streams may be linked to increased habitat variability and more water volume. The headwater regions of river basins have less diverse habitats (both in volume and complexity) and unstable environmental variables (Schlosser 1990).

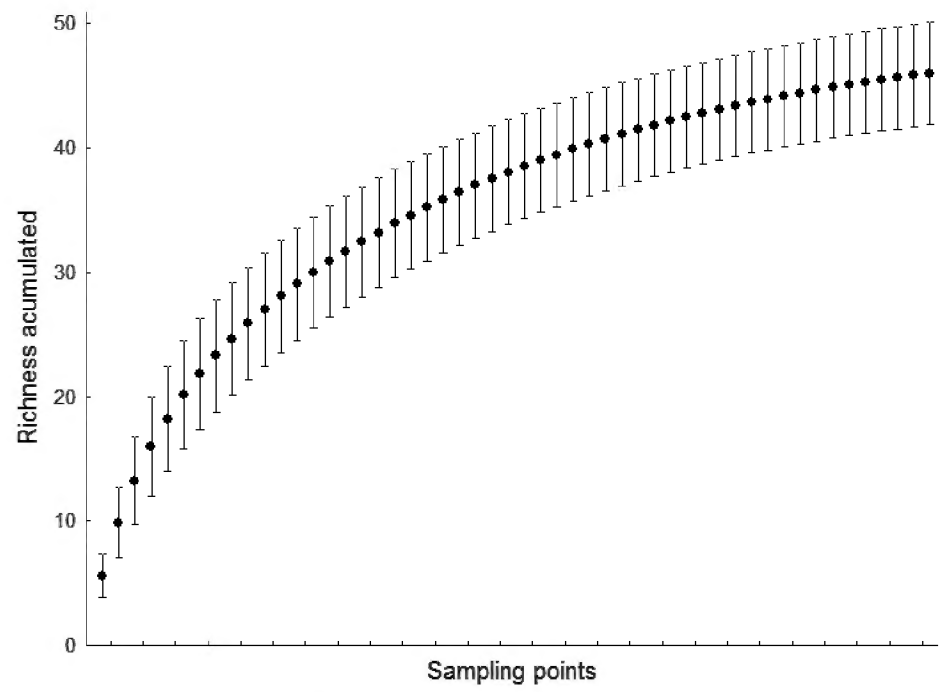

FIGURE 2. Species accumulation curve for the sampled locations in the Aiuruoca River basin.

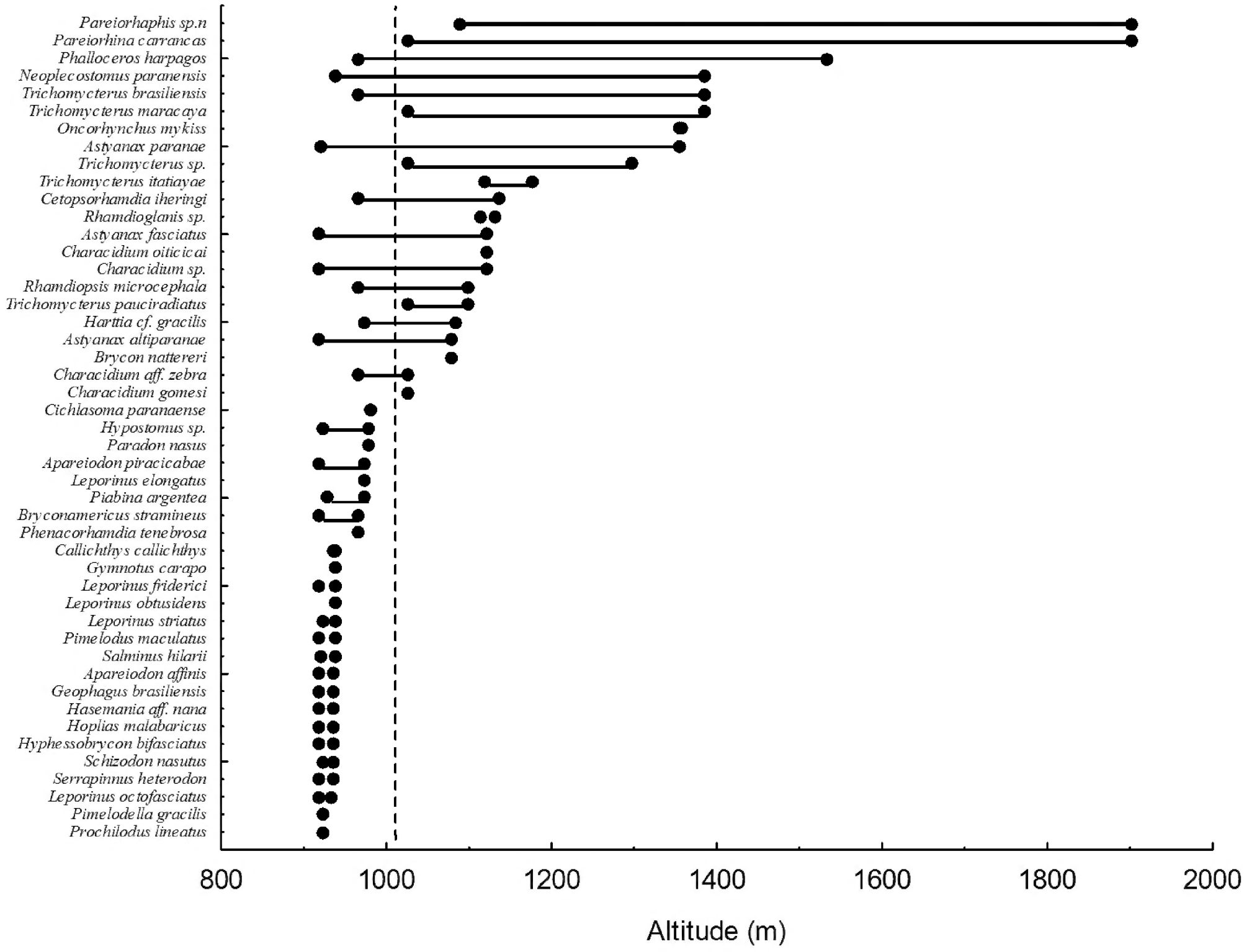

FIGURE 3. Altitudinal distribution of species collected from the Aiuruoca River basin.

Table 2. Fish species collected from the Aiuruoca River basin, by sampled location (N = number of individuals, CI-UFLA = number of UFLA Fish Collection, *exotic species).

TAXON	N	LAGOONS	RIVER	STREAMS
CHARACIFORMES				
Anostomidae				
Leporinus elongatus Valenciennes, 1850	6		CI-UFLA 0381	
Leporinus friderici (Bloch, 1794)	21	CI-UFLA 0366	CI-UFLA 0382	
Leporinus obtusidens (Valenciennes, 1837)	1		CI-UFLA 0383	
Leporinus octofasciatus Steindachner, 1915	6	CI-UFLA 0367		
Leporinus striatus Kner, 1858	12		CI-UFLA 0384	
Schizodon nasutus Kner, 1858	17	CI-UFLA 0371	CI-UFLA 0391	
Characidae				
Astyanax altiparanae Garutti and Britski, 2000	365	CI-UFLA 0355	CI-UFLA 0374	CI-UFLA 0153
Astyanax fasciatus (Cuvier, 1819)	511	CI-UFLA 0356	CI-UFLA 0375	CI-UFLA 0399
Astyanax scabripinnis paranae (Eigenmann, 1914)	237	CI-UFLA 0357	CI-UFLA 0376	CI-UFLA 0155
Brycon nattereri Günther, 1864	4		CI-UFLA 0377	
Bryconamericus stramineus (Eigenmann, 1908)	20	CI-UFLA 0358		CI-UFLA 0393
Hasemania aff. *nana* (Lütken 1875)	2404	CI-UFLA 0363		
Hyphessobrycon bifasciatus Ellis, 1911	925	CI-UFLA 0365		
Piabina argentea Reinhardt, 1867	29	CI-UFLA 0369	CI-UFLA 0387	
Salminus hilarii Valenciennes, 1850	12		CI-UFLA 0390	
Serrapinnus heterodon (Eigenmann, 1915)	474	CI-UFLA 0372		
Crenuchidae				
Characidium gomesi Travassos, 1956	17			CI-UFLA 0154
Characidium oiticicai Travassos, 1967	2			CI-UFLA 0150
Characidium sp. (sensu Pavanelli, 2007)	9	CI-UFLA 0360		CI-UFLA 0394
Characidium aff. *zebra* Eigenmann, 1909	145			CI-UFLA 0151
Erythrinidae				
Hoplias malabaricus (Bloch, 1794)	32	CI-UFLA 0364		
Parodontidae				
Apareiodon affinis (Steindachner, 1879)	9	CI-UFLA 0353		
Apareiodon piracicabae (Eigenmann, 1907)	21	CI-UFLA 0354	CI-UFLA 0373	
Parodon nasus Kner, 1859	3		CI-UFLA 0386	
Prochilodontidae				
Prochilodus lineatus (Valenciennes, 1837)	2		CI-UFLA 0389	
CYPRINODONTIFORMES				
Poeciliidae				
Phalloceros harpagos Lucinda, 2008	1045	CI-UFLA 0368		CI-UFLA 0147
GYMNOTIFORMES				
Gymnotidae				
Gymnotus carapo Linnaeus, 1758	3	CI-UFLA 0378	CI-UFLA 0378	
PERCIFORMES				
Cichlidae				
Geophagus brasiliensis (Quoy and Gaimard, 1824)	846	CI-UFLA 0362		
Cichlasoma paranaense Kullander, 1983	1	CI-UFLA 0361		
SALMONIFORMES				
Salmonidae				
Oncorhynchus mykiss (Walbaum, 1792) *	5			CI-UFLA 0156
SILURIFORMES				
Callichthyidae				
Callichthys callichthys (Linnaeus, 1758)	2	CI-UFLA 0359	CI-UFLA 0401	
Heptapteridae				
Cetopsorhamdia iheringi Schubart and Gomes, 1959	32			CI-UFLA 0148
Phenacorhamdia tenebrosa (Schubart, 1964)	1			CI-UFLA 0395
Pimelodella gracilis (Valenciennes, 1835)	1			CI-UFLA 0396
Rhamdioglanis sp.	4			CI-UFLA 0397
Rhamdiopsis microcephala (Lütken, 1874)	8			CI-UFLA 0149
Loricariidae				
Hypostomus sp. (sensu Pavanelli, 2007)	4		CI-UFLA 0380	
Harttia cf. *gracilis* (Oyakawa, 1993)	31		CI-UFLA 0379	
Neoplecostomus paranensis Langeani, 1990	83		CI-UFLA 0385	CI-UFLA 0157
Pareiorhaphis sp. n.	117			CI-UFLA 0158

Table 2. ***Continued.***

TAXON	N	LAGOON	RIVER	STREAM
Pareiorhina carrancas Bockmann and Ribeiro, 2003	945			CI-UFLA 0160
Pimelodidae				
Pimelodus maculatus Lacepède, 1803	23	CI-UFLA 0370	CI-UFLA 0388	
Trichomycteridae				
Trichomycterus brasiliensis Lütken, 1874	77		CI-UFLA 0392	CI-UFLA 0159
Trichomycterus itatiayae Miranda Ribeiro, 1906	3			CI-UFLA 0398
Trichomycterus maracaya Bockmann and Sazima 2004	35			CI-UFLA 0161
Trichomycterus pauciradiatus Alencar and Costa 2006	5			CI-UFLA 0146
Trichomycterus sp. (sensu Pavanelli, 2007)	7			CI-UFLA 0340
TOTAL	8562			

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